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Global patterns of fisheries conflict: Forty years of data

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ABSTRACT

International fisheries conflict can cause crises by threatening maritime security, ecosystems and livelihoods. In a highly connected world, the possibility for localized fisheries conflict to escalate into 'systemic risks', where risk in one domain such as food supply can increase risk in another domain such as maritime security and international relations, is growing. However, countries often choose hard-line actions rather than strategies initiating or repairing fisheries cooperation. To design, prioritize and implement more effective responses, a deeper understanding of the temporal and regional patterns of fisheries conflict is needed. Here, we present novel findings from the first global and longitudinal database of international fisheries conflict between 1974–2016. We explore the characteristics of conflict over time and develop a typology of eight distinct types of conflict. Fisheries conflict increased between 1974 and 2016, with substantial variation in both the type of conflict and the countries involved. Before 2000, fisheries conflict involved mostly North American and European countries fighting over specific species. Since then, conflict primarily involved Asian countries clashing over multiple and nonspecified species linked to illegal fishing practices. We use this empirical data to consider potential response strategies that can foster maritime security and thereby contribute to broader societal stability.

1. Introduction

Fisheries conflict has the potential to reshape global international relations by threatening maritime security, ecosystems and livelihoods. Conflict over fisheries in the 1960s and 1970s triggered the establishment of Exclusive Economic Zones (EEZs) for coastal states in the 1980s. A single fishery offense over halibut (*Reinhardtius hippoglossoides)* escalated into serious tensions between Canada and Spain in the mid-1990s (Sullivan, 1997). More recently, conflict over fisheries in the EU has fuelled British nationalist sentiments and the successful "Leave" campaign to withdraw the United Kingdom from the European Union (EU) (Appleby and Harrison, 2017). Prolonged shifts in the distribution of the northeast Atlantic mackerel *(Scomber scombrus)* in the Atlantic triggered an international dispute over the stock's management, resulting in unilateral import embargos, vessel seizures and access restrictions, which in turn played a role in Iceland's decision to withdraw its application for EU membership (Spijkers and Boonstra, 2017). Repeated Chinese fishing fleet incursions into foreign waters have sparked diplomatic and military tensions between China and countries both near (e.g. Philippines), and far (e.g. Argentina) (Zhang, 2016). Incursions by foreign trawlers into the Somalian EEZ incited conflict between Somali and foreign fishers, and, according to some scholars, contributed to the emergence of piracy in the region (Sumaila and Bawumia, 2014, Belhabib et al. 2019, for a different view on this link, see Hansen, 2011). Even seemingly unobtrusive or 'subdued' international fisheries conflicts, characterized by hostile verbal interactions and the failure to reach management agreements, threaten transboundary fish stocks (Ishimura et al., 2014).

These examples show how international conflicts over fish can, and have, created cascading ruptures in humanity's highly interconnected social systems (Helbing, 2013). Fisheries conflict is often the outcome of interdependent failures within our global system due to interactions between conditions such as climate change, fragile states, food security concerns, extractivist logics, and unresolved territorial disputes, and

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can escalate to become so-called "systemic risks" (Pomeroy et al., 2007; Helbing, 2013; Galaz et al., 2017). Systemic risk is here defined according to Helbing (2013,pp.51) as "the risk of having not just statistically independent failures, but interdependent, so-called 'cascading' failures in a network of *N* interconnected system components". The potential for fisheries conflict to escalate into systemic risk in the future and trigger cascading shocks throughout the global system is an important concern for policy makers. Potential developments include, for instance, that increasing domestic demands for fish in combination with collapsing stocks could be met with increasingly aggressive resource grabs and open conflict between states (Higgins-Bloom, 2018). Alongside oil and mineral resources, fisheries have already proven to be a common source of international conflict (Mitchell and Prins, 1999). Although the particular focus in this paper is interstate conflict, significant disputes over marine resources also occur regularly between communities and individuals within states (McClanahan et al., 2015; Morrison, 2017).

Conditions known to trigger fisheries conflict are likely to become more widespread and interactive in the future (Pinsky et al., 2018). Through altered water temperatures, changing ocean currents and coastal upwelling patterns, climate change is affecting the distribution and potential yield of marine species (Cheung et al., 2010; Sumaila et al., 2011; Jones and Cheung, 2017). Shifts in abundance and distribution are increasingly understood as a security threat, as those changes are expected to disrupt management of fish stocks (Spijkers and Boonstra, 2017; Pinsky et al., 2018). Additionally, overfishing and resulting declines in catches (Pauly and Zeller, 2016) are also considered to be potential security threats and may directly result in increased levels of Illegal, Unreported and Unregulated (IUU) fishing (Österblom et al., 2011). Security threats might then arise due to an increase in frontier-related incidents involving transboundary poaching and IUU fishing (Boonstra and Österblom, 2014; Yeh et al., 2015; Hughes et al., 2012). Climate change, increased resource scarcity, illegal activity and territorial disputes are just some of the worrying global conditions and trends that increase the possibility of international fisheries conflict becoming a systemic risk in the future, causing disruptions to propagate through global networks (Pomeroy et al., 2007; Pinsky et al., 2018; Zervaki, 2018, Belhabib et al. 2019). Maritime security scholars are increasingly recognizing this potential risk, and have identified that fishery conflicts cannot be grasped in isolation, but are embedded within broader and often synergetic relations including vulnerability, poverty, adaptation, and resilience (Germond and Mazaris, 2019; Pomeroy et al., 2016).

Hard-line and crisis-driven actions characterizing many international fisheries conflicts show us that, currently, governance institutions often lack an efficient, swift and peaceful approach to detect and respond to conflict in fisheries. Actions range from vessel seizures, to port closures and even the attack of vessels, and can prolong disputes to the detriment of international relationships and raise concern for the sustainability of fishery resources (Spijkers and Boonstra, 2017). Prolonged conflict and insecurity can open up areas to increased fishing efforts by third parties as physical control of the territory wanes (Hendrix and Glaser, 2011), while the potential for conflict can result in accommodation, co-optation or corruption on the part of enforcement forces, thereby undermining sound management of fisheries (Sumaila et al., 2017; Belhabib et al., 2018a,b).

For governance systems to adequately respond to fisheries conflict and systemic risks in the face of environmental and societal change, scholars have called for the increased monitoring of system dynamics (Helbing, 2013; Galaz et al., 2017; Frank et al., 2014) and the collection of 'big data' to develop realistic explanatory models to ultimately better understand the occurences and drivers of systemic risks (Helbing, 2013; Spijkers et al., 2018). Monitoring systems and scanning for trends to detect early warning signals of risks are vital to increase the necessary institutional capacity to adequately respond, for example by developing appropriate conflict mitigation measures (Galaz et al., 2017; Boyd et al., 2015). There has, however, been little monitoring of occurences of fisheries conflict, and large, comparative datasets have been nonexistent. As a result, we have little knowledge of the diversity, geography and frequency of international fisheries conflict (Spijkers et al., 2018), which raises the risk of leaving these potentially systemic risks undetected. Moreover, being unaware of the different types of conflict that might occur raises the risk of implementing ineffective governance strategies (as strategies tend to be appropriate only for specific kinds of conflicts (Slimani et al., 2006)).

In this study, we provide the first longitudinal analysis that uses a large comparative dataset to scan for global patterns and trends in international fisheries conflict. We answer the following questions:

1) What is the frequency of international fisheries conflict over time?
2) What types of fisheries conflict events exist internationally and what actors are involved?
3) What strategies are used to respond to different types of conflict?

To answer these questions, we apply descriptive statistics, ordination and cluster techniques on novel data from the International Fishery Conflict Database (IFCD), which was developed from media reports of fisheries conflict to explore international conflicts over fishery resources between 1974 and 2016, n = 531 fisheries conflict events (see Materials and Methods). In that database, we tracked six variables: the countries involved in the conflict event, the species mentioned, the date of the event, the intensity of the observed behaviour or action in the event (based on the scale from Spijkers et al. (2018), see Table 1), whether the event mentioned a specific territory under dispute, and whether the event was linked to IUU fishing or not. Those variables are used to analyze which types of conflicts have occurred.

Table 1
Intensity of observed behaviour/action. Source: Spijkers et al., 2018.

Intensity of observed behaviour/action	
Intensity	**Description**
5	**Military acts causing death** - Attack of foreign vessels, crew members or Coast Guards, with resulting deaths
4	**Military acts** - -Attack of foreign vessels, crew members or Coast Guards, no death toll
3	**Political-military hostile acts** - Sending out police vessels/ warships - Seize vessel and/or crew - Gear destruction - Reinforcing borders
2	**Diplomatic-economic hostile acts** - Breaking or not adhering to existing agreement - Lawsuit - Trial in court - Seeking international arbitration - Trade ban - Fishing ban - Landing ban - Monetary penalties - Close ports
1	**Verbal expressions displaying discord or hostility in interaction** - Failing to reach an agreement - Making threatening demands and accusations - Threatening sanctions - Condemning specific actions, behaviors or policies - Requesting change in policy - Civilian protests
0	**Non-significant acts**

2. Materials and methods

2.1. The international fishery conflict database

The IFCD contains 531 reported conflict events between 1974 and 2016. It was set up to explore international conflicts over fishery resources by using event data, i.e. detailed records of interactions between actors (countries) (Shellman, 2004). An international fishery conflict is a dispute:

(a) actualized through ‘conflict events’, which are actions or behaviors ranging from an exchange of statements to severe military involvement and casualties (as defined by the ‘intensity of observed behavior’ scale, see Table 1).
(b) occurring between two or more states and/or vessels that fly their flag;
(c) related to access to a fishery resource or management of a fishery resource;
(d) potentially occurring in the larger context of a maritime territorial conflict, where the fishery resource contributes to some degree to that territorial conflict;
(e) spanning any length of time.

Event data were identified through the LexisNexis Academic (LNA) database, the world's largest repository of media reports, using the following search terms: “trade ban”, “seize AND vessel”, “close w/5 ports”, “no w/5 agreement”, “sanction”, “attack w/5 vessel”, "conflict AND tribunal" in combination with 28 specific fish species, as well as the general term of “fish” (w/5 means ‘within five words’). The search terms were used to detect the actions and behaviors from the intensity scale (see Table 1 displaying the scale developed by Spijkers et al. (2018), based on reviewed fishery as well as fresh water conflict literature). The 28 specific species were selected based on the commercial groups within the SeaAroundUs database (Pauly & Zeller, 2015) (see SI Table S1). We entered into the database those results that were relevant based on our definition of a conflict event. We tracked the following event characteristics: number of countries involved, the species mentioned, the date, the intensity of the observed behaviour or action (Table 1), whether a specific territory under dispute was mentioned, and whether or not it was linked to IUU fishing. We tracked territorial disputes and IUU because those variables spark much concern among scholars in terms of future maritime security (45), and because they are maritime security threats that can be a feature of a larger fisheries conflict. In contrast, we did not track maritime security threats such as human trafficking or smuggling (Bueger, 2015), because they are not a direct feature of a fisheries conflict that centers primarily around the ownership or management of fish. Once the database was assembled, we grouped different conflict events together that were continuations of the same conflict over time, which are those that happened between the same countries or the same species (see SI Methods: IFCD for further details).

We ran several analyses to understand if the IFCD was biased by the media sources we extracted it from. Firstly, to analyze if the conflict data within the IFCD was correlated to the level of English media output in different countries (see SI Figure S2 for further details on coverage by LNA), we extracted the content list from the LNA website (from the European region) for analysis. This content list is available for download through the database’s webpage and contains information, amongst others, on the date of addition of all news sources, their coverage start/end, the geographical region covered, and the language of the news source. This allowed us to assess to what extent media coverage of a given country or year in LNA affects the frequency of conflict events for that given country or year within the IFCD. We also extracted the Press Freedom Index scores for the countries in the IFCD (Reporters Without Borders, 2018). After using robust regression (downweighing outliers) with heteroscedasticity-corrected standard errors, we did not find that either the media coverage in the LNA or the press freedom score of a country had a significant relationship with conflict frequency in the IFCD for that country. We tested this relationship for all countries in the IFCD, but also looked more closely into that relationship for those countries in the database where the primary de facto spoken language or de jure language is English, and ran an analysis for the USA in particular (as it was an outlier in the previous analyses) (see SI Results: Media Bias). None of the analyses showed a consistent relationship between media coverage in the LNA and conflict frequency in the IFCD. Secondly, to analyze if the conflict data per year is correlated to the amount of media coverage per year, we extracted the list of publishers from the LNA website (the European region). Using cross correlation analysis, we found no significant correlation between conflict and media coverage, even when taking into account time lags (see SI Figure S4). Although we found no evidence of undue influence of media coverage on country or yearly conflict frequency within the IFCD, we note that this does not mean the database is free of any bias as a result from searching English media: we warn for the likely underreporting of (minor) conflicts in regions with non-English speaking news media within the IFCD, such as countries located in South America and Africa. For a more elaborate discussion on the media bias analyses, see SI Results: Media Bias.

2.2. Conflict event categorization

To distinguish between different types of fisheries conflict, we use non-metric multidimensional scaling (NMDS) complemented with hierarchical cluster analysis to categorize different types of fisheries conflict based on the variables that characterize the conflicts (including potentially causal correlates) (Chatfield, 2018; Dixon, 2003). First, we use NMDS to visualize conflict event groupings based on multivariate dissimilarity, and we determined the variables that explain the spread of conflict events across groups. We chose to conduct our NMDS along three axes because this was the minimum number of axes where a computationally stable result was generated with low stress. Our resulting NMDS plot had a stress value of 0.085, indicating low distortion from 7-dimensional space to 3-dimensional space (see SI Figure S9).

Second, we use hierarchical cluster analysis to determine the grouping of conflict events and complement the NMDS. For the hierarchical clustering, we use scree plots of the dissimilarity between clusters versus the number of clusters to determine a number of clusters that forms a natural break where there is comparatively not much more dissimilarity difference by adding an additional cluster (Henry et al., 2005). We conducted each of the analyses using three widely used dissimilarity measures (Jaccard’s, Bray-Curtis, and Gower’s), and found all three to generate the same clusters. We use the results from the Gower’s dissimilarity as this dissimilarity measure is best suited for mixed-data situations (Legendre and Legendre, 2012). All categorical data with two states (IUU fishing and whether an event was part of a larger territorial dispute) was converted to a binary variable, and categorical variables with three states (the type of fishery) was converted to dummy variables for the analysis.

We then ran a time series analysis of the clusters to understand when in time the clusters were more or less present, and combined this with the place-specific data (i.e. continents) to understand which combinations of conflict between continents are most represented in the clusters (see SI Figure S10). We used the R package vegan for NMDS and clustering analysis (Oksanen et al., 2018). We used the R packages MASS (Venables and Ripley, 2002) and lmtest (Zeileis and Hothorn, 2002) for the regression analysis. From that, we also got the frequency of continent configurations per conflict cluster (see SI Table S2).

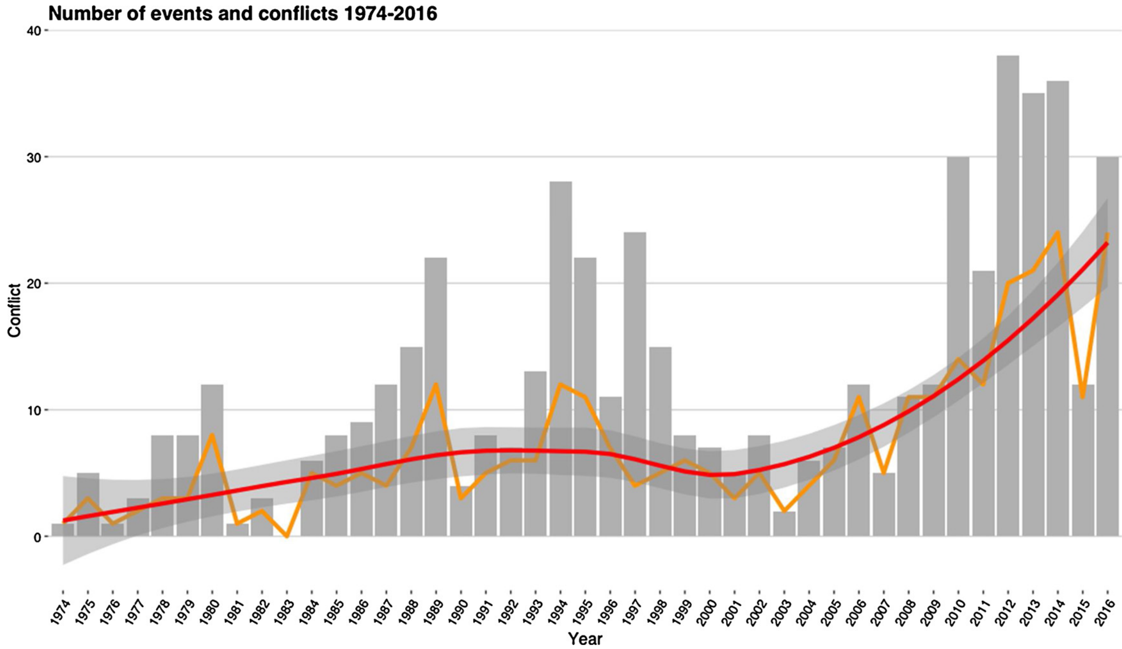

Fig. 1. Conflict events (bars) and conflicts (orange line), 1974–2016. Conflicts are aggregated events part of the same overall conflict (see Materials and Methods). LOESS smoother (red line) added for visual interpretation of growth in conflicts (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

3. Results

3.1. Fisheries conflict increases over time

The frequency of conflict has increased since 1974, although there was a period of lower reported conflict between approximately 1998–2007 (Fig. 1). Intra-continental conflict (64.8% of all conflict events) was more common than inter-continental conflict (35.2% of all conflict events) during the entire time period. The USA was involved in most conflict over time, followed by Canada, Japan, China and the EU; all of these high-conflict countries have been predominantly in conflict with countries located within the same continent (see SI Figure S1). As discussed above, we ran analyses, but found no evidence that the dataset we developed was biased due to national differences in media coverage, the degree of press freedom, nor a reflection of the amount of media coverage per year (Materials and Methods).

3.2. Changes in fisheries conflict types over time

The non-metric multidimensional scaling and cluster analysis (Materials and Methods) identified eight different types of fisheries conflict events (Fig. 2).

Despite the eight types of fisheries conflict, there are overarching general trends across all conflict events. Firstly, Type A (discord over a particular species), has been the most commonly occurring conflict event between countries over time (35.0% of all conflict events). Secondly, almost all deadly conflict events have occurred over non-specific species (84.6% of all deadly conflict events). Finally, for all types it was rare for events to take place between more than two countries, yet if this did occur, the event was most likely to be conflict Type A (21.0% of Type A events take place between more than two countries).

The occurrence of the eight different conflict event types within and between continents are illustrated in Fig. 3. Three different constellations of conflict were particularly frequent: intra-North America conflict, intra-Europe conflict, conflict between Europe and North America and intra-Asia conflict, which collectively represent 74.8% of all conflict events. In the following, we examine the conflict trends across each of those four constellations over time (Materials and Methods).

3.3. Intra-continental conflict in North America and Europe

Conflicts between North American countries (19.2% of all events) and between European countries (17.1% of all events) have been similar in types observed throughout time. Discord over a particular species (conflict event Type A) is the main kind of conflict occurring among North American countries and among European countries, such as over cod (*Gadus morhua)*, salmon (*Salmo salar*) or Albacore tuna *(Thunnus alalonga)*. Those conflicts largely occurred in the past for North America, while Europe is currently dealing with fishery disputes surrounding the northeast Atlantic mackerel and Atlanto-Scandian herring (*Clupea harengus)*. Besides these low intensity discords over a particular species, North American actors have also been involved in some shows of force triggered by illegal catches of specific species (Type C conflict events), which can have a higher intensity. However, those are no longer very common.

3.4. Europe-North America conflict trends

European and North American countries have often been involved in international fisheries conflicts (11.5% of all conflict events). Similar to the intra-Europe and intra-North American conflicts, the conflict is generally associated with a particular species (Type A conflict events) such as cod or, more recently, American plaice *(Hippoglossoides platessoides)*. These events occur relatively consistently throughout time. A type of conflict event that frequently occurred between European and North American countries before the turn of the century is the diplomatic hostility over a particular fish linked to unresolved territorial tensions (Type F conflict events). That type is exemplified by the cod dispute between France and Canada linked to disagreements around the extent of the maritime jurisdiction of St-Pierre and Miquelon.

3.5. Intra-Asia conflict trends

Intra-Asia conflicts occur most frequently (26.9% of all conflict events) and the region is most diverse in the types of conflict events

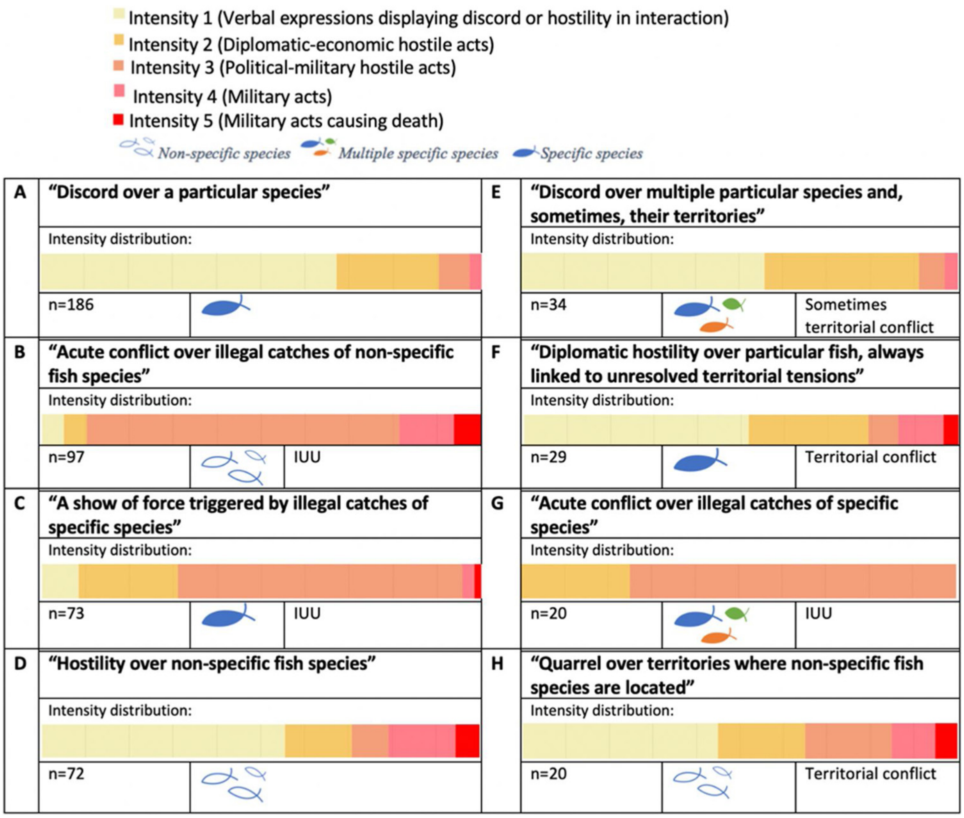

Fig. 2. Eight conflict event types and their narrative descriptions.

documented (all different types have occurred for intra-Asia conflict). Since 2000, 43.0% of all international fisheries conflict events occurred between Asian countries. The most violent events have also taken place between Asian countries (sometimes resulting in the death of fishermen or Coast Guard officials). The most common kind of intra-Asia conflict event is the acute conflict over illegal catches of non-specific fish species (Type B conflict events), which have increasingly occurred since 2004. The second most common type is hostility over non-specific fish species (Type D conflict events), which became more frequent over the past decade. Quarrels over territories with general fish biomass is the third most frequently occurring conflict event between Asian countries (Type H events). Those disputes include competing claims for fishery rights around the islands off eastern Hokkaido (the Kuril Islands, claimed by both Russia and Japan), the Senkaku Islands (disputed by Japan, China, and Taiwan) and the Scarborough Shoal (claimed by both China and the Philippines). These conflicts events have been most common from 2007-2016.

4. Discussion

4.1. Examining changing patterns of international fisheries conflict

Our analysis suggests that the nature of, and countries engaged in, fisheries conflict have changed substantially over the past 40 years. Many of the countries most frequently involved in conflict are large industrial fishing powers known to dominate global fishing efforts, but they have engaged in conflict at different points in time (Teh and Sumaila, 2015; Tickler et al., 2018). Spain and the UK, for instance, dominate European fishing effort along with Russia (Anticamara et al., 2011), and are among the ten countries with the largest number of fisheries conflict events. In Asia, Japan was long the dominant fishing power in terms of fishing effort, but has more recently been surpassed by China and South Korea (Tickler et al., 2018). All three are also among the ten countries most frequently involved in conflict. The USA and Canada are responsible for the majority of North/Central American fishing effort, again often engaged in conflict in the past. Some countries have large Distant Water Fishing (DWF) fleets that have continually expanded their geographical presence and have been cited for engaging in illegal or unreported fishing (such as the DFW fleets of certain European countries and China, see (Belhabib et al., 2015; Carolin, 2015)); which could be a reason for their frequent engagement in conflict with other nations.

Type A, C and F conflict events involving North American and European actors (related to single species, mostly characterized by low conflict intensity and sometimes territorial disputes), were relatively common particularly before the turn of the century. This echoes findings by Daniels and Mitchell (2017) that advanced democracies regularly have conflict over maritime issues (with the Americas in particular exhibiting high rates of maritime conflict). They suggest that this is likely the consequence of being more able and thus active to pursue claims, and having relatively high levels of economic activity in their maritime domains (Daniels and Mitchell, 2017). After the turn of the century, conflict involving North America and European states became less common, as many conflicts were resolved through negotiated agreements. Important changes to the system's institutional architecture were made through agreements over boundaries, such as the decision by the International Court of Justice in 1984 on the Georges Bank delineation; and agreements over fisheries management, such as the Pacific Salmon Interception Treaty in 1985 for the Pacific Northwest, revised in 1999 (Rogers and Stewart, 1997), and the Transboundary Resource Assessment Committee for the Gulf of Maine in 1998 (Pudden and Vanderzwaag, 2007). Those institutional changes contributed to de-escalating fisheries conflict and preventing them from cascading throughout the system. In addition, it is also conceivable that conflict among and between North American and European actors has subsided in part due to a relatively high rate of species collapse in the higher latitudes (Watson and Pauly, 2013), potentially leaving less to argue over after the year 2000.

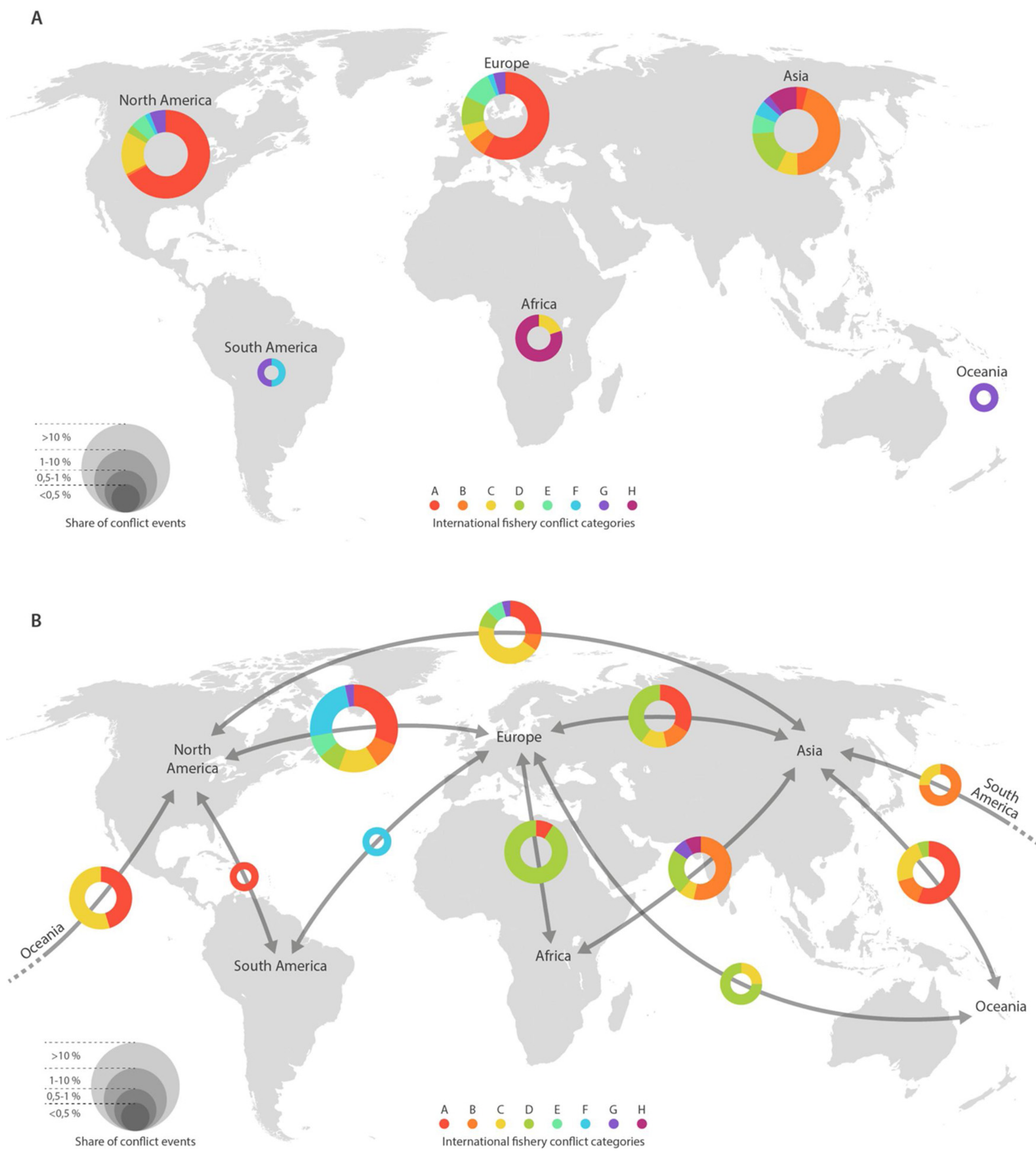

Fig. 3. Distribution of intra-continental (A) and inter-continental conflict events (B).1974–2016.

The frequency of Type B, D and H conflict events between countries in East and Southeast Asia (focused around non-specified fish species) can be explained by the multispecies fisheries common to tropical and highly diverse marine ecosystems. The increase in fisheries conflict between Asian actors might be a consequence of overfishing of major fisheries in temperate northern waters, and subsequent displacement of conflict risk to other regions by relocating the locus of fishing effort (Watson and Pauly, 2013; Worm and Branch, 2012), combined with subsequent overfishing within the Asian region. The conflict events are often characterized by illegal fishing and higher intensity actions, which likely reflects the rapid expansion of fishing effort by East and Southeast Asian fleets, such as those from China (Rogers and Stewart, 1997; Blasiak et al., 2015) and South Korea (Anticamera et al., 2011). Competition for control of resources with other states, as well as illegal activities and (violent) conflicts, ramped up since 2007 (Carolin, 2015). Low intensity disputes over specific species also occur between Asian countries, such as the ongoing conflict over Pacific saury (*Cololabis saira*) where Japan has proposed setting catch limits for the stock but has seen its proposal blocked by China (Kyodo, 2018). Our analyses show that disputed territories in Asia currently present grave security concerns for fisheries. As fleets venture farther out, crew risk entering off-limits or disputed waters and engaging in fishing potentially unauthorized due to ongoing territorial rivalry (Mallory, 2013).

4.2. Response strategies

There are historical precedents for strategies that have been effectively put in place by countries to respond to certain conflict types we have considered, and we outline those below. We distinguish between foundational and specialized risk mitigation strategies for the different conflict types (Table 2). Foundational strategies are those that have proven generally helpful in resolving conflict of any kind, whereas specific strategies are those that can help prevent particular types of conflict from escalating. We note that these strategies are mostly technical and legal in nature, and might not efficiently address issues that have deeper social, political or economic roots requiring much

Table 2
Selection of foundational and specific response strategies for the different conflict types.

	A	B	C	D	E	F	G	H
Foundational strategies	Scientific collaboration Shared enforcement							
Specific strategies	Side payments Long-term management plans				Side payments Long-term management plans			
						Provisional fishery agreements		Provisional fishery agreements
		IUU policies					IUU policies	

broader solutions.

For all conflict types, creating a **shared scientific understanding** of stocks and aquatic ecosystems more generally has historically proven valuable as a first step to conflict mitigation.

Scientific collaboration, through shared monitoring and coordinated data collection, often provides a basis for negotiation. The establishment of the Baltic Marine Environment Protection Commission - Helsinki Commission (HELCOM), for example, was crucial as it served as a platform for a non-threatening political exchange between the Soviet Union and the other Baltic states. The literature on transboundary cooperation over fresh water resources underscores the importance of joint fact-finding among nations as an important catalytic tool to move from conflict to cooperation, where information disclosure through data-sharing and monitoring is regarded as a first and key step in conflict management (Xie and Jia, 2017; Mitchell and Zawahri, 2015; Uitto and Duda, 2002). However, scientific collaboration on fishery issues is not implemented in certain areas with high conflict risk, with substantial constraints existing in the volatile South China Sea (Zhang, 2018), although it could be initiated by an existing regional governing body (such as the Southeast Asian Fisheries Development Center (SEAFDEC)).

The establishment of **shared enforcement activities**, especially in areas where conflict relates to IUU, is another important foundational strategy to reduce conflict risk. The Joint Fisheries Commission between Russia and Norway, for example, is an arena where countries exchange observers on each other's control vessels or coordinate satellite tracking systems, which has aided in creating a coordinated response to rampant IUU (Stokke, 2009). The lack of joint enforcement actions not only leads to an uneven marine space where areas of high enforcement and monitoring create spaces with high fishing pressure but no enforcement; it can also result in violent, militarized conflict responses to IUU between countries. However, in fisheries conflicts where not only IUU is an issue but also overlapping territorial claims, addressing territorial boundary tensions is a pre-requisite, and one not easily fulfilled. For example, being a party to UNCLOS encourages the use of third-party dispute settlement techniques, but it does not reduce militarized tensions over contested maritime spaces between states (Nemeth et al., 2014).

Side payments, or compensating transfers in the form of monetary or in-kind compensation from one party of a conflict to another, provide incentives to stay in a coalition where otherwise payoffs between countries would differ (Cole et al., 2014). This kind of conflict mitigation tool requires some form of an established institution for the purpose of collaborative management (such as a Regional Fisheries Management Organization (RFMO)). Side payments in the form of contributions to a conservation fund helped resolve a number of conflicts surrounding specific species, such as the Pacific salmon conflict between the USA and Canada (Pinsky et al., 2018; Miller and Munro, 2004). More recently, side payments have been put forth as a tool to resolve the northeast Atlantic mackerel dispute, where access to or quota for other species such as Atlanto-Scandian herring could be used to increase the scope for bargaining and forego conflict.

Long-term management plans that allow for changes in stock distributions have proven to be essential in creating successful fisheries management plans for specific stocks, if territorial issues and IUU fishing are largely absent (Bundy et al., 2017). The revised Pacific Salmon Treaty (1999), for example, replaced short-term management regimes with a longer-term plan where harvest shares were defined on stock abundance indices (Rogers and Stewart, 1997), avoiding frequent renegotiation of catch allocation. Coupled with side payments, the revised long-term management plan significantly enhanced collaboration between the parties.

Provisional fishery agreements that explicitly recognize territorial disputes will be essential in avoiding fisheries conflict in areas with overlapping territorial claims. Taiwan and Japan, for example, recognized this issue and forged in 2013 a fisheries agreement designating the waters around the Diaoyutai/Senkaku Islands a 'non-specific area', thereby treating territorial sovereignty as a separate issue (Yeh et al., 2015). This agreement reduced tensions and helped to promote stability in the East China Sea, as fishermen have been able to avoid detention or penalties from the opposing claimant country (Yeh et al., 2015).

Stringent IUU policies are necessary to avoid conflicts events characterized by IUU. There are a few effective, non-belligerent IUU policies that can be implemented by coastal states, such as banning transshipment (or the transfer of fish between boats) at sea or requiring a vessel monitoring system (VMS) tracking the vessel's location. Both policies were implemented recently by Indonesia, with great success (Cabral et al., 2018). Market states that are major consumers of fish can demand stricter traceability standards to combat IUU in foreign waters. The EU, for example, requires catch documentation for imported seafood. Modifying the policies and procedures of financial services in the insurance sector in such a manner that it denies benefits to those that engage in IUU fishing, could greatly reduce conflicts related to this illegal practice (Miller et al., 2016). Other measures should include preventing the reflagging of fishing vessels to tax havens, removing subsidies from fishing fleet owners and investors tied to IUU activities, and more comprehensively listing vessels, companies, and beneficial owners involved in illegal fishing activities (Belhabib and Le Billon, 2018).

4.3. Response gaps

There are historical examples of successful strategies for fishery conflict de-escalation. However, there is no standardized, swift procedure for dealing with conflict situations in a non-escalatory manner yet, and it often takes years for governments to agree on an effective strategy to end conflicts that have already damaged international relations and fish stocks. Moreover, the two foundational strategies are not applied in certain conflict-prone areas: to our knowledge, scientific collaboration between South-East Asian countries, for example, has only been initiated in a few areas (such as the Coral Triangle Initiative for Coral Reefs, Fisheries and Food Security between six Asian countries in the Coral Triangle (Weeks et al., 2014)) despite an increase in Type D events. This is problematic as, depending on the extent of warming, certain EEZs in East Asia are projected to receive up to 10 new stocks by the end of the century (Pinsky et al., 2018), and new entrants into already saturated territories are more likely to spark disagreement (Blasiak et al., 2015). These response gaps increase the possibility for conflicts to become systemic risks. To promote wider and swifter implementation of the strategies discussed, deep changes to the current international governance framework for fisheries will be necessary (through, for example, revisions of RFMO competences and operations (Pinsky et al., 2018)).

Besides responding swiftly to conflict once it has erupted, countries also need to manage the incremental stressors that either drive conflict to erupt in the first place, or that push fisheries conflicts to become systemic risks. For this, more region-specific research is needed into underlying and proximate drivers of conflict, and how they interact to produce wider systemic risks. We suggest three specific topics for attention: the impacts of climate change as a driver (so as to better identify conflicts likely to result from unprecedented rates and magnitudes of change) the key drivers of conflict in Asia (so as to better prevent even more widespread and severe conflicts that could result in systemic risks) and the importance of fish abundance as a driver of conflict (so as to better understand the role of responsible fisheries management for conflict prevention). Research on conflict drivers within fisheries can also further facilitate a discussion on indicators of potential imminent fishery conflict and how policymakers might use those to develop responses. For instance, it might be possible to simplify the eight conflict types according to appropriate policy prescriptions. Finally, we advise continued monitoring of the occurrence and types of fisheries conflict that occur globally to follow-up trends and gain greater accuracy.

5. Conclusion

The world has become highly interconnected, and as a result, a crisis in one part of the global system can trigger cascading shocks in other sectors. In certain instances, international fisheries conflict has already negatively affected international relations and fishery sustainability. Conflicts need to be swiftly and peacefully addressed to avoid escalation into globally extensive, systemic risks with unforeseeable consequences. To design effective response strategies and prioritize them geographically, the regional frequency and nature of fisheries conflict has to become clearer. For that purpose, we developed and analysed the International Fishery Conflict Database and show that international fisheries conflict increased between 1974 and 2016, shifted largely from occurring between and among countries within North America and Europe to countries within Asia, and included eight distinct types of fisheries conflict events. More recent conflict types involve greater severity, nonspecific species, IUU, and territorial disputes. We discussed foundational and specialized risk mitigation strategies for the different conflict types, and highlighted existing response gaps.

Many international fisheries conflicts have been successfully resolved in the past, but often only after much damage to both international relations and fish stocks. In some parts of the world where conflict has been increasing, even the most foundational procedures for dealing with conflict situations in a non-escalatory manner do not exist, increasing the possibility for localized fisheries conflicts to escalate into systemic risks. In the face of climate change impacts, resource scarcity, illegal activity and territorial disputes, conflict management across political borders becomes essential for environmental sustainability, human health and maritime security. Fisheries conflicts, their impacts and their drivers need to be considered more rigorously by scientists and government.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.gloenvcha.2019.05.005.

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